Sustainability in Lighting Control Systems

DALI Alliance

While lighting has become much more efficient in recent years, it still represents around 15% of the world's electricity consumption and accounts for 5% of global greenhouse gas emissions[3]. This means that lighting should be a top priority when considering sustainability.

All organizations must reduce their energy consumption and carbon footprint, with legislation in many countries making this compulsory rather than just an optional goal. As well as reducing emissions, there's a win-win of cutting energy costs by improving the efficiency of lighting, as well as the benefits of a more sustainable, low-waste approach in terms of lower capital expenditure and replacement costs.

In this article we'll look at how smart, data-rich lighting control systems can help businesses achieve their sustainability goals. We'll also discuss the contribution of global standards such as the Digital Addressable Lighting Interface (DALI®).

Lighting Control Reduces Energy Usage

Sustainability in lighting starts with reducing energy consumption – thus cutting carbon emissions and reducing running costs.

Even with power-saving light sources such as LEDs, most commercial buildings have poor lighting efficiency because the lights are often on when the illuminated spaces are not in use. Lighting typically accounts for around 20 to 30% of total energy costs, depending upon the building type, so the potential savings are huge.

While even simple timers are better than relying on building occupants to switch off the lighting, a much more effective approach is to use an automated lighting control system. Enabled for example by DALI (**Figure 1**), the control system could use sensors to detect occupancy, movement and daylight levels. This adds to the gains achieved using LED light sources in combination with simple control techniques like switching and dimming.

PIR (passive infrared) sensors can detect occupancy in different parts of the building, and the system can then turn lights on and off in response – a large system may have thousands of such occupancy sensors. DALI sensors coupled with occupancy-based data analytics provide an extremely useful tool for facility managers who need to cut electricity consumption.

Another way to reduce energy consumption is with light-level sensors, which detect how much natural light is available in particular locations, so artificial lighting can be controlled in response. This 'daylight harvesting' method considers factors such as time of day, the sun's position in the sky and even the time of year.

Sensor-based lighting control can optimize both the brightness and color temperature of the artificial lighting and monitor environmental conditions to create a comfortable environment for building occupants. As well as promoting health and well-being, this can also help drive higher productivity in workplaces.

Overall, the more sophistication, more functions, and more intelligence in a lighting control system, the greater the energy savings. This requires suitable software that is intuitive and user-friendly, and straightforward controls and user interfaces that building occupants will be able to understand and use. DALI's role here is to standardize the functionality of input devices such as switches, sliders and push-button devices.

Figure 2 summarizes how DALI contributes to sustainable lighting systems.

Data Drives Results

The DALI protocol enables smart, data-rich networks in which the feedback and exchange of data is enabled by two-way digital communication. DALI control gear such as LED drivers routinely report their output levels, lamp failure information, emergency test data and other information to application controllers, the decision-making devices in a DALI system. DALI sensors and other input devices all provide valuable data that feeds into the lighting-control system and can trigger automated, real-time changes.

Several DALI data specifications have been developed to standardize the location and format of new types of data that can be stored in control gear. This data, which relates to light sources, luminaires and the drivers themselves, can be used for asset management, energy monitoring, diagnostics, predictive maintenance, and many other applications.

[3] Data from the US Department of Energy

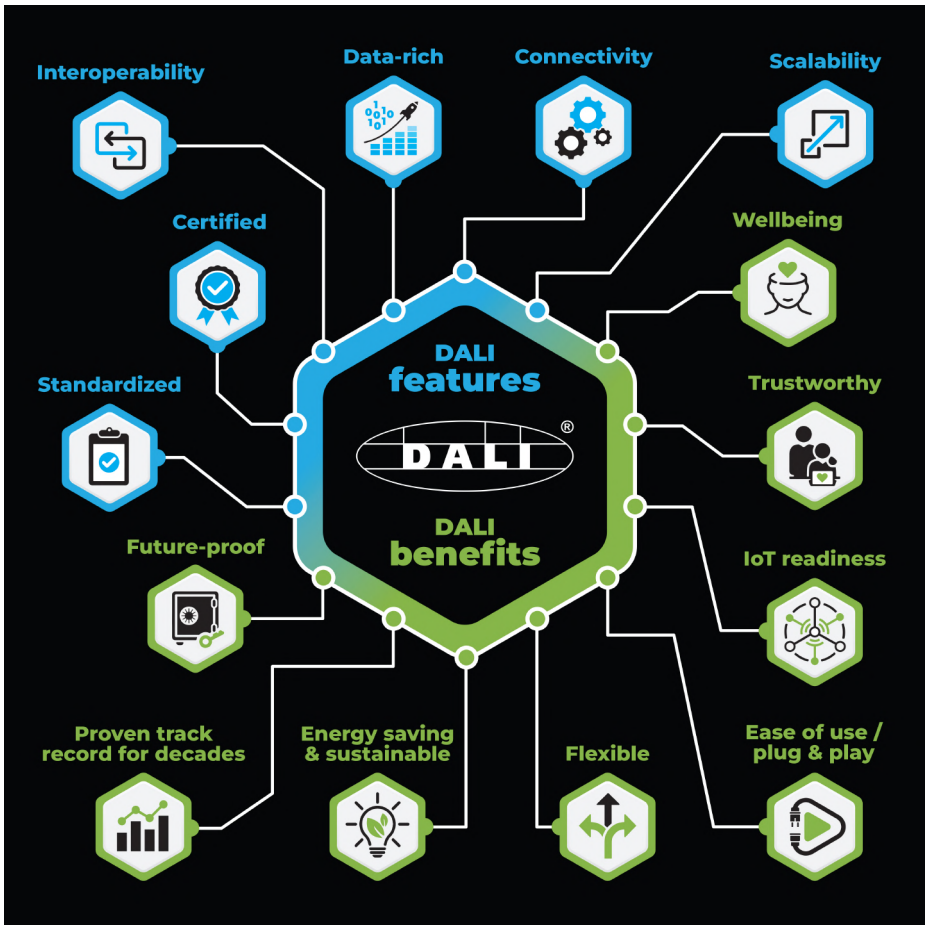

Figure 1: DALI features and benefits.

Figure 2: DALI can make important contributions to sustainable lighting systems via futureproofing, extended luminaire lifetimes and reduced energy usage.

To quantify the savings achieved through the effective use of a lighting-control system, we also must have effective monitoring of energy consumption—savings must be measured, not guessed. As well as measuring the overall energy usage, we need to get granular information of what's actually happening in specific areas of a building, or even inside individual luminaires – and DALI-compatible sensors can achieve this. Data of this kind can also prove crucial in applying for energy rebates.

Also, LED drivers can report a wide range of operational and diagnostics data, so the system can proactively alert the manager to any faults. Data analysis can predict when individual components or fixtures should be replaced, rather than employing a comprehensive replacement schedule after a fixed period of time. Significant savings can be achieved by employing a data-driven 'predictive maintenance' strategy, contributing to the overall sustainability of the lighting-control system.

Sustainable, Flexible and Future Proof

As well as reducing energy consumption, sustainability also includes factors such as reduced materials usage and recycling in line with the UN's Sustainable Development Goal 12: Responsible Consumption and Production. The main driving forces for sustainability are legislation, environmental issues, and social responsibility.

Another factor is the trend toward a 'circular economy', which has found broad support, including a policy and regulatory framework in the European Union (EU)[4]. Products that can be reused, refurbished, upgraded and recycled offer the potential for less waste, lower energy consumption and financial savings.

In the lighting industry, there is an increasing drive for replaceable components that extend the service life of luminaires. If suitable components are available – and if replacement is possible – then luminaires can be repaired, or upgraded with new and improved features and functions.

Here, the strength of DALI as a globally standardized protocol comes to the fore. The DALI-2 certification program, developed and maintained by the DALI Alliance, has created an ecosystem of interoperable products from multiple vendors. This ensures the long-term availability of com-

[4] https://www.europarl.europa.eu/news/en/headlines/economy/20151201STO05603/circular-economy-definition-importance-and-benefits

patible components, and avoids vendor lock-in and reliance on proprietary solutions that may not be supported in the future.

DALI-2 also provides backwards compatibility with earlier products. The DALI protocol has been around for decades, supported by all major players in the lighting industry. New extensions and certification programs (such as DALI-2, D4i and DALI+) are forward-looking and – crucially – standardized.

DALI is flexible and lends itself to future-proof designs that extend the useful life of a lighting control system. Changes to the design of a DALI system and how it is operated can often be dealt with by software reprogramming, rather than having to rewire or replace luminaires and other equipment. This could, for example, allow a building operator to easily change the layout of office spaces to accommodate new tenants.

Futureproofing is enabled at the luminaire level by the Zhaga-D4i connector system, which facilitates plug-and-play replacement of luminaire-mounted sensors and communication nodes. Zhaga-D4i combines the standardized mechanical interface from the Zhaga Consortium with the communication and power requirements specified by the DALI Alliance as part of the D4i certification program[5].

Zhaga-D4i certification has enabled an ecosystem of interoperable luminaires and control devices. This allows luminaire owners to easily update their fixtures, protect their investment, sustainably extend the life of the luminaire, and keep pace with fast-moving developments in digital networking and sensing technologies.

Look, No Wires

While wired systems provide network stability and reliable connectivity, there is growing interest in wireless capabilities, which should be considered in future-proofing any system.

With a wireless lighting control system, it's possible to position wireless control devices without having to run network cables (although power is still required). This can increase flexibility while also making it easier to scale up systems and add new devices. With no new cabling, labor and material costs are reduced, and there's less damage to the building.

[5] www.dali-alliance.org/d4i

Two approaches have been developed that combine the DALI protocol with wireless technology.

Firstly, the standardized gateways[6] approach enables wired DALI networks or D4i/DALI-2 luminaires to be incorporated into wireless ecosystems such as Zigbee or Bluetooth Mesh.

Then, the DALI+ approach enables DALI to be used over wireless and IP-based networks, thus increasing choice and flexibility. The DALI Alliance is developing certification programs for both the standardized gateways and DALI+ with Thread as the carrier[7].

There are some scenarios where a wired solution is preferred or required. In different circumstances, hybrid solutions may be desirable. DALI provides choice and keeps future options open by enabling wired and wireless networks to operate together. For example, wireless DALI+ networks can incorporate bridges that provide a link to a wired DALI network, with DALI used throughout as the communication language.

DALI+ over an IP-based carrier such as Thread also opens the possibility to integrate the lighting system with other functions via a building's IT infrastructure.

DALI in Action

Lighting control systems based on DALI have been adopted around the world – here are a few examples that were among the winners of the 2022 DALI Lighting Awards[8].

The winning project in the Industrial[9] category, submitted by Synapse Wireless, was the Uline Store C6 in Ontario, California, USA.

Figure 3: Uline Store C6, Synapse Wireless.

This indoor warehouse uses more than 4,000 Cree luminaires with D4i drivers, connected by wireless networked lighting controllers. DALI data enables the system to achieve energy rebates, meet strict energy codes, and provide alerts when the lights are not operating as designed. Light sensors enable daylight harvesting, making optimum use of the facility's 76 skylights. DALI control enables smooth dimming that maximizes comfort for employees.

[6] www.dali-alliance.org/wireless/gateways.html
[7] www.dali-alliance.org/daliplus
[8] www.dali-alliance.org/awards2022
[9] Industrial Category

In the Infrastructure[10] category, Delmatic was the winner for the Elizabeth Line, a new 118 km high-speed rail network in and around London, UK.

Figure 4: Elizabeth Line, Delmatic.

This is Europe's largest infrastructure project, lit entirely by LEDs and the complete installation uses DALI control to optimize efficiency, safety and aesthetics. DALI systems provide energy-efficient management and monitoring of normal and emergency lighting throughout the Elizabeth line stations, using more than 35,000 DALI assets, including luminaires, sensors, switches and controllers. Many DALI features were employed, including real-time monitoring and diagnostics, as well as occupancy and light-level sensors.

The Winner of the Residential[11] category was Shenzhen Sunricher Technology for the Taiziwan High-end Building in Shenzhen, PR China.

Figure 5: Taiziwan High-end Building, Shenzhen Sunricher Technology.

This large residential building, with 33 floors, uses DALI lighting control connected with the KNX building management system. More than 10,000 DALI drivers are used to achieve accurate, stable and smooth dimming without flicker. A key advantage of DALI was the ability to manually

[10] Infrastructure Category
[11] Residential Category

set the addresses in advance, thus saving the time required for on-site commissioning. DALI supports the use of preset scenes to automatically control light according to the functions of different areas, different times of the day, and outdoor light intensity.

In the Architecture & Entertainment[12] category, the winner was Tridonic for the Expo 2020 Entry Portals in Dubai, UAE.

Figure 6: Expo 2020 Entry Portals, Tridonic.

The portals are 10.5m wide, 21m tall and 30m in length. Recessed inground luminaires with customized optics provide a glare-free solution for pedestrians. Dynamic color mixing, delivered by DALI control, varies from warm white to an intense amber color at sunset, recreating the warmth of the natural Dubai light. DALI drivers enable the color temperature and brightness of the customized IP67 luminaires to be easily controlled by a single channel. In turn this reduces the amount of wiring and the complexity of the installation. DALI also helped the designers to meet the energy reporting and code requirements of the project.

The winner of the Healthcare and Education[13] category was Delmatic for the University College London Hospital.

Figure 7: University College London Hospital, Delmatic.

In this 11-floor building (of which 5 floors are below ground), DALI helps to minimise energy usage, and enhance sustainability and operational efficiency. Precise DALI dimming and scene-setting in response to daylighting and occupancy enables flexible lighting schemes in different areas of the hospital, while enhancing the comfort and wellbeing of patients and occupants. DALI contributed to the building receiving BREEAM Highly Commended certification, which is a challenge to attain in a highly-serviced healthcare building with energy-hungry medical equipment.

In the Outdoor[14] category, the winner was Signify for the lighting renewal project in Algeciras, Spain.

Figure 8: Lighting renewal project in Algeciras, Signify.

Zhaga-D4i luminaires from Philips are connected via an outdoor luminaire controller attached to the Zhaga-D4i socket. This allows the luminaires to transfer DALI data to the Interact City connected lighting system, enabling users to remotely manage, monitor, and control the city lights. The control system dynamically provides energy consumption data and asset information, enabled by data stored in the D4i LED drivers. The system is future-ready due to the interoperability provided by standardized DALI and Zhaga-D4i technology. Overall, the new system has reduced energy consumption by more than 50%.

The winner of the Workspaces[15] category was Bluebottle for the office space at 83 Pirie Street in Adelaide, Australia.

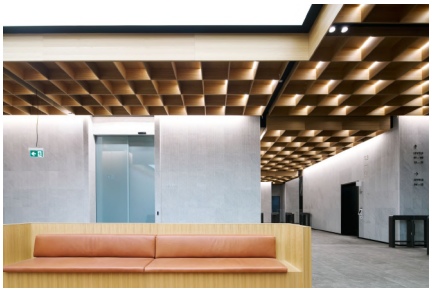

Figure 9: Office space at 83 Pirie Street in Adelaide, Bluebottle.

This 22-level office tower uses DALI throughout, for both illumination and emergency lighting, with components supplied by zencontrol. The DALI-2 application controllers ensure that DALI data is available to the BACNET building management system for monitoring and control. Integrated sensors are widely used, and DALI data provides analytics on the power consumption and savings from daylight harvesting and occupancy detection. DALI was chosen for its flexibility and ease of wiring. Bringing all the exit and emergency fittings onto the DALI bus along with the lights, motion sensors and switches greatly reduced the complexity of the wiring and offered substantial cost savings.

The Winner in the Retail and Hospitality[16] category is Delmatic for Battersea Power Station.

Figure 10: Battersea Power Station, Delmatic.

This iconic building in London has been transformed into a mixed-use destination. The precise dimming and scene-setting capabilities of the DALI-2 system enable flexible lighting layouts and scenes to be applied throughout the building, which contributes to a welcoming ambience and facilitates wayfinding. The DALI system is integrated with the DMX lighting that illuminates the building exterior. User interfaces and applications continuously monitor the complete lighting ecosystem and display real-time granular data and intelligent analytics on lighting performance. This includes DALI-2 emergency light monitoring and testing, as well as individual lamp and driver failure diagnostics.

Conclusion

To achieve sustainable lighting, a control system based on the DALI system can deliver the required reductions in energy usage, as well as ensuring a future-proof solution that minimizes unnecessary equipment replacement.

Taken together, this means that DALI can reduce total cost of ownership, while helping organizations to meet their sustainability goals. ■

[12] Architecture & Entertainment Category
[13] Healthcare & Education Category
[14] Outdoor Category
[15] Workspaces Category
[16] Retail and Hospitality Category

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